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THE CONSERVATION AND CORRELATION OF VITAL FORCE.

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IT is but lately that physicists have proven to the satisfaction of other men equally learned, that there does exist a series of compensations in the forces of nature; and that heat, light, motion and other powers, more or less unknown, not only may be converted, the one into the other, but that their exact equivalents may be stated in infallible mathematics. This had been dimly foreshadowed long ago, but its final proving belongs to our day. Vital force, however, from its very essence is more intractable, and overrides mathematical restrictions, willing (so far as we can now see) to acknowledge similar relations of the most general character only.

There is no denying that the most sublime mental endowments may in the same individual be associated with the most hopelessly ridiculous, and we are hence prepared to accept as true, or at least as not improbable, that the "greatest, wisest" of mankind could also be the "meanest." Indeed, second thoughts may convince us that surpassing intelligence in one direction, implying unbroken devotion to a given line of study, almost of necessity, entails a corresponding ignorance in other lines of mental activity for which no leisure hours can be found.

But whilst we are foiled in any attempt at estimating the exact amount of vital or purely mental force in excess in one direction, which it will require to compensate for a deficiency in some other, we may nevertheless, with some degree of certainty affirm that such relations do exist.

Geoffroy Saint-Hilaire not only recognizes the existence of this principle of compensation, but has drawn largely upon it in his teratological studies.

De Candolle, after granting the relation between excessive growth and atrophy, states that it is often exceedingly difficult to decide whether the former determines the latter, or the converse.*

* De Candolle, Theor. elem., ed. 1, § 73.

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It is, then, with no claim to originality that this is written, but rather to call for the more general recognition of a law already noted by the more observing ones. We may be unable to explain it, or, what is still more damaging to its chances of acceptance, be unable to show how it is to chime in directly with any form of evolution; for to this we have all now come; still it remains a law, as active as any other, even though it be less sharply defined.

If called upon to express what I believe concerning it, I would say: that all organic things, plants or animals, have a certain proportionate amount of developing force, actual or predestined, and that this synergy is under the direction of inherited tendencies; which being at times misdirected, one organ or set of organs may take on excessive growth. Should this occur, there will be a corresponding atrophy in some other organ or set of organs. Now against this statement of what I conceive to be underlying all growth, many instances can be adduced. Still the facts in its favor, when fairly marshalled, seem to me so preponderating as to make them more than mere coincidences.

The scope of this paper allows me to cite but a few out of the many instances I could give. Among plants, take as an illustration *Larrea Mexicana* Moric., the creosote plant of the southwest. It is a representative of the bean-caper family. Inside the base of each filament (which is filiform) is a large two-cleft scale conspicuous enough to attract attention. It is not unusual to find filaments whose bases are not filiform, but are broadly expanded. *Erodium Texanum* Gray is a capital example of this. Besides, this same plant has an outer circle of five stamens which are minus their anthers, a fact which I might turn to account in my argument did space permit.

Now morphology would settle the question concerning the essential nature of the scales of Larrea, by saying that they are the homological equivalents of the stipules we usually find on the right and left sides of the petioles of leaves, and more or less intimately united with them, only in this case instead of being lateral they are intra-petiolar, *i.e.*, between the petiole and the axis of the plant, just as the stipules are occasionally found. To this explanation no exception can be taken, in so far as it goes. But the question still remains unanswered, why it is, when most plants have neither these scales nor the broad bases to their filaments, in the example I have just given, where a decided tendency to cell proliferation

exists, this proliferation should manifest itself in one direction only, *i.e.*, either as scales or broad bases to the filaments, but not both in the same plant?

Gaura, again, furnishes an example of the scales associated with slender filaments, and many more like cases could be brought forward. After some examination I am now unable to find a *distinct, unequivocal contradiction* to the principle I have enunciated. I am not prepared to affirm some do not exist. Indeed I should be surprised if they did not.

The typical anther of our conception is possessed of two cells. Sometimes, however, there is but one, which may often be explained by the partition wall being obliterated, and so causing the confluence of these usually separate cells. In Salvia (sage), however, there is but one cell where two might certainly have been expected. One has gone, entirely, or at most a mere knob of cellular tissue may remain to suggest the missing cell. Interposed between the perfect and the imperfect cells is a connective, unduly elongated, which from its very length and association with the separated halves of the anther serves to explain the want of development in the one. In other words the connective is vigorous and lusty at the expense of the impoverished cell.

Or take that illustration, almost too familiar to be alluded to here, the transformation of the stamens of the wild rose into the petals of the cultivated. It is a simple change of direction given to vital force, but, in so far as I can see, is no superadded power of development. Cultivation may turn the energies of the savage into a new channel, perhaps a higher one in some respects, but it does not follow that it is therefore, because higher in this sense, any indication of greater vitality or force of development. It is simply evidence of a transfer of power, and nothing more.

I have now in my possession an ear of Indian corn on which the grains have failed to develop, the chaff surrounding the grains being on the other hand enormously overgrown. If this instance stood alone I should be willing to admit that the failure of the grains to grow simply allowed room for their envelope to take on so unusual a size. I could, however, were I disposed, cite a long list of cases in which so mechanical an explanation would fail. I will quote a few, freely translated from Moquin-Tandon.

"M. Duval has observed flowers of verbascum, in which the filaments of the stamens took on an unusual growth, and at the

same time lost the usual hairs."* "In certain excessive developments of the parts of the vegetable the hairs abort incompletely, or entirely."† "Mr. Joseph de Caffarelli has given to me a somewhat dwarfed branch of bitter-sweet, which is covered with an enormous number of small hairs."‡ "In *Phleum Boehmeri* the inferior palet of the flower is dilated sometimes beyond measure; the edges then are soldered together at the base; at the same time the superior palet, and the pedicel of the rudimentary flower, abort entirely."§

"I have observed a monstrosity of *Faba vulgaris*, the stipules of which had taken on an enormous increase; they were changed into oval, foliaceous limbs, half arrow-shaped and slightly sinuous; at the same time the limbs of the ordinary leaves had disappeared entirely."‖

"In a monstrosity of *Muscari comosum*, all the flowers had aborted; at the same time the peduncles had become longer."¶

"Lately there has been communicated to the Société d' Agriculture de la Haute-Garonne a spike of corn which presented a curious example of this last balance; all the flowers were found in a normal condition except one, of which the calicinal envelopes had taken on a growth almost double their natural size; the surface of this flower was covered with a thick coat of hairs, and its appearance resembled much that of a flower of the "folle avoine."**

"In some flowers the atrophy of the stamens coincides with the hypertrophy of the pistils. For example, in certain individuals of *Lychhnis dioica* the male organs are found dilated, so that the pistils are represented by small, gland-like bodies; but in the other flowers the female organs are much developed, so that the stamens are reduced to simple rudiments; the same phenomenon occurs in *Spiræa Aruncus*, and in *Sedum Rhodiola*."†† In this last quotation we have plants associating themselves with such as our *Houstonia cærulea* in which, (belonging to hermaphrodite genera) there is a manifest tendency to assume that higher sexual organization where the individual shall be prepotently either male or female, as the one or the other set of organs takes on unusual growth. In other words, it seems to be a good illustration of the principle of vital compensation applied to function as well as to structure.

Mr. Thomas Meehan has furnished us a case directly in point

*Tératologie Végétale, p. 63. † *Idem*, pp. 62 and 63. ‡ *Idem*, p. 68. § *Idem*, p. 157.
‖ *Idem*, p. 156. ¶ *Idem*, p. 156. ** *Idem*, p. 158. †† *Idem*, p. 158.

in *Fragaria vesca* L. I quote him almost verbatim. "When it does not produce stolons, the number of flower spikes is increased, and, as they cannot run as stolons, they make up for this by continual axial production, bearing a succession of flowers through the whole season."

"Sometimes the runner party will so get the upper hand that the pistils will be entirely suppressed, in which case the runners push out with so much enthusiasm as to crowd down and frequently destroy their floriferous neighbors. In fact, just in proportion as the plant becomes truly fruit bearing, and with a tendency to produce a succession of fruit on the same stock, is the tendency to produce runners checked." He then gives a modification of the above, but which is still a case in point.*

The same journal contains a description of a double early saxifrage with a small *panicle*, *double flowers* and *no trace of either stamen or pistil*.†

The animal kingdom would furnish us with still more striking illustrations. A fact I had long suspected concerning hydrocephalic children met lately with a most unexpected confirmation in the distinct, unequivocal testimony of one of the most distinguished living pathologists. "The process of enlargement in these cases is often one of simple growth, and that indeed to a less extent than it may seem at first sight; for it is very rarely that the due thickness of the skull is attained while its bones are engaged in the extension of their superficial area. *Hence the weight of an hydrocephalic skull is not much, if at all, greater than that of a healthy one;* a large parietal bone, measuring nine inches diagonally, weighs only four ounces, while the weight of an ordinary parietal bone is about three ounces."‡

In his admirable text-book on "Diseases of Children," 2d edition, page 298, Dr. J. Lewis Smith under head of "Anencephalic Children," writes:—"The vault of the cranium is absent. There is a deficiency of the frontal, parietal and occipital bones, except those portions which are near the base of the cranium. These portions are very thick and closely united as if there were *the usual amount of* osseous substance, but instead of expanding into the arch, it had collected in an irregular mass at the base of the cranium."

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*American Naturalist, August, 1869, pp. 328 and 329. † *Idem*, p. 327.
‡ Surgical Pathology, Paget, pp. 58 and 59. Third English edition.

Quoting again from the same author we are told:—"Hypertrophy of the brain is associated with rachitis, and stunted growth."* Under rachitis, he informs us that, "while in the first and second stages, there is an arrest of ossification and a deficiency of calcareous salts in the system, there is often in the third stage, as Lebert has stated, an exuberance of ossification and a superabundant deposit of the salts of lime, so that the reconstructed bone is stronger and firmer than the normal bone."†

Here then it would seem as though the compensation might extend over different intervals of time, one period being marked by a plus quantity, another by a minus:—a happy illustration of what John Hunter called the "body's memory." For this we are not entirely unprepared. The "stale" condition of overtrained pugilists is as much due, after all (some things lead us to suppose), to an excessive demand on their vitality as to subsequent dissipation; and the early break down of so many of our best college gymnasts is but another fact in the same category. Overdraw your bank deposit at one time and you are left a debtor at another.

Failure of the long bones to properly develop in their longitudinal direction under certain conditions of disease is connected with undue thickening of the same bone.

Turning now to the domain of surgery proper:—it is probable that the vast majority of new growths will be found to occur in advanced age, or at least after the "prime of life." I exclude ovarian tumors for manifest reasons.

So commonly do we find scirrhus tumors of the breast associated with declining years, that age is always made an element of the diagnosis. The testimony of Paget on this point is most explicit. His table of the frequency of cancer at the different periods of life is

Under 10 years	5
Between 10 and 20 years	6·9
" 20 " 30 "	21
" 30 " 40 "	48·5
" 40 " 50 "	100
" 50 " 60 "	113
" 60 " 70 "	107
" 70 " 80 "	126‡

Op. Cit., p. 374. †*Idem*, pp. 98 and 99. ‡Third English Edition, p. 798.

thus showing that its frequency is more than twenty-five times as great between seventy and eighty years as at ten years of age.

Does it not seem as though the still unused strength, lacking in these declining years a legitimate employment, were engaging in the development of a low grade of cells whose vitality was insufficient for their own stability? This however is but a poor hypothesis to account for a well proved fact.

Be all this as it may, however, of this there is no doubt:—that after the removal of an *external*, malignant growth at an advanced stage of development, the chances of disease of the same character attacking an internal organ are greatly increased: hence prolongation of life is seldom gained by a surgical operation.*

Mr. John Simon gives an explanation of some of these facts I have derived from medical literature. I quote him, as they possibly may have a wider application. "But besides this antagonism effected through the general circulation, there probably are antagonisms of a local character; and parts which are respectively supplied by different contiguously-rising branches of one arterial trunk seem specially able thus to antagonize each other. For assuming the flow through an arterial trunk to remain the same, one branch, or set of branches can only transmit more blood, if, simultaneously, another branch or set of branches transmit less; and we may well conceive it to be an important function of vasi-motor nerves to provide for the adjustment of this antagonism, by establishing such inter-arterial sympathies that the relative opening of one branch shall determine the relative closure of another."† If not too mechanical and in contravention of vasi-motor function, I would venture to suggest that the relative *closure* of one branch might determine the *opening* of another, by forcing more blood through the latter. This would only account for those instances of the organic balance in which the plus and minus were in organs supplied from the same arterial trunk, *i.e.*, anatomical relatives. On the next page however the same author takes a more comprehensive view of his subject and says:—"Textural excitability perhaps is not so exclusively local but that in this respect also these may be conditions of inter-textural balance; the total excita-

*I am aware of the statistics of Velpeau regarding the removal of cancerous growths, but as they are so greatly at variance with the observation of the mass of surgeons, I do not regard them as invalidating my statements.

†Holmes' Surgery, 2d edition, Vol. i, p. 80.

bility of the body at any given moment being perhaps of fixed amount; so that with regard to excitement, just as with regard to blood-supply, plus in one organ would imply minus in another."*

I am unable to say just what views were entertained on this subject by Geoffroy Saint-Hilaire: — not having access to his writings. Milne-Edwards gives the following clear statement of his own opinion. "The principle of connection of organs regulating the place occupied by each; a tendency to an organic balancement, equipoise, or compensation when the development of an organ acts, as it were, injuriously upon others, as if the amount of vital force were restricted and limited.†"

Finally, I quote the following at second hand from Meckel. It seems almost too strange to be true, but as the authority is above reproach we can only accept it as a fact. Let it be observed that here, however, "this antithesis extends over different children of one and the same mother. A girl had on each extremity a superfluous digit, and one hand of her sister wanted four, being the number of digits which her sister had in excess, reckoning the four extremities together.‡"

These are a few out of the immense mass of similar illustrations I might bring forward in support of my belief in an absolute law at the bottom of these correlations of structure, and may I not add:— often of function?

There are many facts on the other hand, which seem to militate against it. But it appears to me most likely that as we more thoroughly understand the principles of biology, in the same measure will our exceedingly vague ideas on this subject become more determined and absolute:— in fact the evidence must almost of necessity, like that in favor of the theory of gravitation, become of a cumulative character. Any other supposition would imply a belief in the ancient idea of a *lusus naturæ*, which is opposed to the most firmly grounded dogmas of modern science.

Any decided deductions in the way of distinct propositions concerning this law are as yet premature, but the following may find some support in the cases I have already given:—

1st. That organs anatomically or physiologically related tend to compensate among themselves for any aberration of structure or function.

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* *Idem*, p. 81.

† Manual of Zoology. Translated by R. Knox, edited by Blake, edition 1863, p. 200.

‡ Cyclopedia of Anatomy and Physiology, Vol. iv, part 2d. p. 946.

2nd. That an organ over-developed in one direction will be under-developed in some other: *e.g.*, the case of the long bones, already cited.

3rd. That time may be an element in this compensation: *i.e.* in rachitis deficient deposit of bony material may be followed later in the disease by an excessive deposit of it in the same bones.

4th. That the influence of this law may extend from one conception to another, as illustrated by the case related by Meckel.